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Exploring the nexus: prevalence, risk factors, and clinical correlations of urinary tract infections in diabetes mellitus patients - a comprehensive retrospective analysis

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ABSTRACT

Aims: This study investigates the frequency and associated factors of urinary tract infections (UTIs) in patients with diabetes mellitus (DM).

Methods: This retrospective chart review focused on patients with diabetes mellitus. Data collection involved demographic details, DM diagnosis, comorbidities such as hypertension, hyperlipidemia, and coronary artery disease, along with medication usage. Laboratory values including blood glucose and HbA1c levels were also analyzed. The primary outcome of interest was the diagnosis of UTI, identified from clinical records.

Results: 173 DM patients were included in the study. These patients were divided into two groups according to the presence of UTI: 52 patients in the UTI group and 121 patients in the non-UTI group. The incidence of UTI was significantly higher in women (37.9%) compared to men (10.2%). No significant differences were observed between the groups in terms of age, presence of hypertension, hyperlipidemia, or coronary artery disease. Interestingly, the usage of SGLT-2 inhibitors was significantly higher in the UTI group compared to the non-UTI group (26.8% vs. 14%, p=0.043). No significant differences were found in other medication usage or in the levels of glucose and HbA1c between the groups.

Conclusion: The study highlights the increased risk of UTIs in DM patients, particularly among women and those using SGLT-2 inhibitors. These findings suggest the need for careful monitoring and tailored approaches in managing UTIs in DM patients, considering gender and specific DM treatments.

Keywords: Complication, diabetes mellitus, urinary tract infection

INTRODUCTION

Diabetes mellitus (DM) occupies a forefront position among global health challenges, contributing to an increase in metabolic irregularities as well as a heightened risk of infections.[1-3] This disease is characterized by a combination of conditions including insulin resistance, reduced insulin secretion, and increased glucose production.[4,5] The prevalence of DM has escalated rapidly in recent years, particularly in developing countries. This surge is linked to various factors associated with lifestyle changes. As of 2015, approximately 415 million adults worldwide were reported to be living with DM, with projections suggesting an increase to 642 million by 2040.[6]

DM markedly elevates the risk of critical health concerns, including cardiovascular diseases, visual impairments, extremity losses, renal disorders, and a range of infections.[7,8] Notably, urinary tract infections (UTIs) are the most frequent among these in diabetic individuals. Around 150 million people globally are estimated to be impacted by UTIs each year.9 UTIs, infections affecting the urinary system, may involve the urethra, kidneys, or bladder. Beyond their discomfort and pain, UTIs pose a significant risk of severe complications if they advance to the kidneys.[10]

This study aims to assess the prevalence and risk factors of UTIs in patients with DM specifically focusing on those in routine outpatient care.

METHODS

This study was conducted with the approval of the Ondokuz Mayıs University Clinical Researches Ethics Committee (Date: 05.05.2023, Decision No: 383). All procedures adhered to ethical standards and aligned with the principles of the Declaration of Helsinki. Ensuring patient confidentiality and data privacy, no data were shared outside the scope of this study.

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This retrospective study included patients diagnosed with DM, presenting to the Internal Medicine Outpatient Clinic of Samsun Gazi State Hospital between September 1, 2022, and February 1, 2023. We included all patients who met the inclusion criteria during the study period, patients under 16 are typically treated in pediatric clinics and thus were not part of this study.

Data Collection

Patient data were collected electronically through the Hospital Information Management System. This approach enabled comprehensive access to various data categories relevant to the study.

Definition and Diagnosis of UTIs

UTI was defined as any infection involving any part of the urinary tract, namely the kidneys, ureters, bladder and urethra. UTI diagnosis was based on urine analysis.

Assessment of Risk Factors and Parameters

The assessed parameters included age, gender, comorbidities (hypertension, hyperlipidemia, coronary artery disease), urine test results (glucosuria), blood test results (fasting glucose and HbA1c), and medication usage (SGLT2 inhibitors, metformin, DPP4 inhibitors, gliclazides, glitazones, and insulin). Risk factors were assessed based on prior studies.

Statistical Analysis

Statistical analysis was performed using the Statistical Package for Social Sciences (version 29; IBM Corp. Armonk, NY, USA). Normality of data distribution was evaluated using the Shapiro-Wilk test and visual inspection of histograms. Descriptive statistics included the use of frequency and percentage for categorical variables, and mean±standard deviation or median (interquartile range, 25th-75th percentile) for continuous variables. To compare categorical variables across independent groups, the chi-square test and Fisher's exact test were applied. For continuous variables, differences between groups were assessed using either the Student's t-test or the Mann-Whitney U test. All statistical tests were two-sided, and a p-value less than 0.05 was considered indicative of statistical significance.

RESULTS

The study included 173 patients. The mean age of the patients was determined to be 60.8±10.8 years. 71.7% of the patients in the study were female. For detailed demographic and clinical characteristics of the study participants, please refer to **Table 1**.

Table 1. Demographic, clinical, and medication characteristics of study cohort

Parameters	Subgroups	Total (n=173)
Age (years)		60.8±10.8
Sex		
	Female	124 (71.7%)
	Male	49 (28.3%)
Co-morbidities		
	Hypertension	98 (56.6%)
	Hyperlipidemia	40 (23.1%)
	Coronary artery disease	19 (11%)
Urine test		
	Glucosuria (mg/dl)	56 (32.4%)
Biochemistry test		
	Glucose (mg/dl)	160 (125-227)
	HbA1c (%)	7.4 (6.7-8.75)
Medication		
	SGLT2 inhibitors	31 (17.9%)
	Metformin	123 (71.1%)
	DPP4 inhibitors	65 (37.6%)
	Gliclazides	26 (15%)
	Glitazones	10 (5.8%)
	Insulin	51 (29.5%)

DM: Diabetes mellitus; UTI:Urinary tract infection; HbA1c:Glycated haemoglobin; SGLT2:Sodium-glucose cotransporter-2; DPP4:Dipeptidyl peptidase 4

They were divided into two groups based on UTI diagnosis: 30.1% (n=52) diagnosed with UTI (UTI group) and 69.9% (n=121) not diagnosed with UTI (non-UTI group) as seen in **Table 2**. The average age in the UTI group was 61.8±10.7 years, and in the non-UTI group, it was 59.4±10.8 years; no statistically significant difference was observed between the groups (p=0.089). The rate of UTI in women (37.9%, n=47) was significantly higher compared to men (10.2%, n=5) (p<0.001).

Table 2. Comparative analysis of demographic, clinical, and medication characteristics between UTI and non-UTI groups in patients with diabetes mellitus

Parameters/ Subgroups	UTI (n=52)	Non-UTI (n=121)	p
Age (years)	61.8±10.7	59.4±10.8	0.089
Sex			
Female	47 (37.9%)	77 (62.1%)	<0.001
Male	5 (10.2%)	44 (89.8%)	
Co-morbidities			
Hypertension	32 (61.5%)	66 (54.5%)	0.395
Hyperlipidemia	13 (25%)	27 (22.3%)	0.701
Coronary artery disease	6 (11.5%)	13 (10.7%)	0.878
Urine test			
Glucosuria (mg/dl)	16 (30.8%)	40 (33.1%)	0.768
Biochemistry test			
Glucose (mg/dl)	160 (125.5-221)	160.5 (124 - 238.75)	0.837
HbA1c (%)	7.4 (6.7-8.65)	7.35 (6.63-8.88)	0.743
Medication			
SGLT2 inhibitors	14 (26.8%)	17 (14%)	0.043
Metformin	40 (76.9%)	83 (68.6%)	0.268
DPP4 inhibitors	20 (38.5%)	45 (37.2%)	0.874
Gliclazides	7 (13.5%)	19 (15.7%)	0.705
Glitazones	2 (3.8%)	8 (6.6%)	0.376
Insulin	13 (25%)	38 (31.4%)	0.397

DM: Diabetes mellitus; UTI: Urinary tract infection; HbA1c: Glycated haemoglobin; SGLT2: Sodium-glucose cotransporter-2; DPP4: Dipeptidyl peptidase 4

No statistically significant difference was observed between the groups in terms of hypertension, hyperlipidemia, and coronary artery disease prevalence (respectively; p=0.395, p=0.701, p=0.878). In the UTI group, the rate of UTI symptoms (69.2%, n=36) was significantly higher compared to the non-UTI group (0.8%, n=1) (p<0.001). Glucosuria was detected in 30.8% of patients (n=16) in the UTI group; this rate was 33.1% (n=40) in the non-UTI group, with no statistically significant difference observed (p=0.768). No significant difference was found between the groups in median glucose and HbA1c values (respectively; p=0.837, p=0.743). There was no statistically significant difference in the usage rates of metformin, DPP4 inhibitors, gliclazides, glitazones, and insulin between the groups (respectively; p=0.268, p=0.874, p=0.705, p=0.376, p=0.397). The prevalence of SGLT-2 inhibitor usage among patients in the UTI group was observed to be significantly higher at 26.8% (n=14), as opposed to 14% (n=17) in the non-UTI group, a difference which was statistically significant (p=0.043) (**Figure 1**).

Figure 1. Distribution of SGLT-2 Inhibitor Usage Among Patients With and Without UTI Diagnosis

DISCUSSION

This research focused on examining the prevalence of UTIs and related risk factors in individuals with DM. The study's outcomes revealed a heightened risk of UTIs, notably among women and those on SGLT-2 inhibitor therapy.

The interplay between DM and UTIs is intricate and multidimensional. DM, marked by disrupted glucose metabolism, potentially enhances infection risks through several pathophysiological pathways. High blood sugar levels, a common phenomenon in DM, create an environment favorable for bacterial growth and adherence, thereby facilitating bacterial colonization in the urinary tract, a prime risk factor for UTIs.[11,12] Furthermore, DM's impairment of the immune system renders patients more susceptible to bacterial and other microbial infections. This increased vulnerability stems from a weakened immune response, disruptions in white blood cell functionality, and bladder dysfunction due to diabetic complications, all contributing to DM patients' heightened risk for UTIs.[13] These pathophysiological considerations play a crucial role in the complex management and prevention of UTIs in the context of DM.

A salient observation from our research is the prominence of female gender as a key risk factor for UTIs in DM patients. This finding is consistent with current literature and can be explained by women's unique anatomical and physiological traits. The proximity of the female urethra to the anus and its shorter length make it easier for bacteria to enter the urinary system, increasing susceptibility to UTIs. Factors such as hormonal variations and conditions like pregnancy further amplify this risk in women.[14,15] The shift in vaginal flora due to estrogen deficiency post-menopause can also heighten UTI risk. Consequently, these factors contribute to a higher prevalence of UTIs in females with DM, underscoring the need for specialized management and preventive strategies in this demographic.

An additional key finding of our research is the increased occurrence of UTIs in DM patients treated with SGLT-2 inhibitors, corroborating with current research on this medication class's impact on UTI risk. Several studies have shown a correlation between specific diabetes management therapies and the incidence of urinary tract infections, highlighting the need for personalized treatment strategies in diabetic patients. Recent research indicates a notable association between the use of SGLT-2 inhibitors in diabetic patients and an increased risk of urinary tract infections, suggesting a need for vigilant monitoring in these patients.[16,17] SGLT-2 inhibitors work by lowering blood glucose levels via inhibition of glucose reabsorption in the kidneys, leading to heightened glucose levels in urine. This elevated urinary glucose can act as a nutrient for bacteria, thereby raising the risk of UTIs.[16] The glucosuria associated with these drugs provides an optimal environment for the growth of bacterial pathogens. High urinary glucose levels create favorable conditions for the multiplication of UTI-causing bacteria, such as *E. coli*. This increased risk is compounded by the pre-existing immune dysfunction in DM patients. The use of SGLT-2 inhibitors necessitates careful consideration in clinical management, emphasizing the importance of vigilant monitoring for UTI symptoms and prompt intervention to prevent complications in these patients.[17,18] In addition to gender and SGLT-2 inhibitor use, factors like the patient's age, the duration and control of diabetes also play a crucial role in the susceptibility to urinary infections.[18]

Recent studies have indicated that hypertension and other comorbid conditions may exacerbate the risk of urinary infections in diabetic patients, suggesting a multifactorial interplay in these individuals.[19,20]

Limitations

In evaluating the findings of this study, acknowledging its inherent limitations is essential. The retrospective nature of the study introduces potential issues, including selection bias and data incompleteness. Compared to studies with a prospective design, retrospective analyses often provide less comprehensive information and may overlook key variables.

CONCLUSION

The study focused on evaluating the prevalence of UTIs and their related risk factors in individuals with DM. The outcomes underscored an elevated risk of UTIs in DM patients, especially in women and those on SGLT-2 inhibitor therapy. These insights are critical for guiding clinical management and developing strategies to mitigate UTI risk in the DM patient population.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of Ondokuz Mayıs University Clinical Researches Ethics Committee (Date: 05.05.2023, Decision No: 383).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper and that they have approved the final version.

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